ICF INTERNATIONAL

Memorandum

Date:	May 10, 2012
To:	David Zippin et al.
From:	Erin Healy (minor edits by Chris Earle)
Subject:	CM13, Methylmercury: discussion

Background and Problem Statement

BDCP restoration actions will increase the acreage of intermittently wetted areas by converting agricultural and other upland areas to tidal, open water, and floodplain habitats, potentially increasing methylmercury production and mobilization in the Plan Area. Mercury is widespread throughout the Delta as a result of transport from historic upstream mining operations. In an inorganic or elemental form, mercury tends to adhere to soils and has limited bioavailability. In an aquatic environment, mercury may be converted by microbes to a different form, called methylmercury, which is much more bioavailable and toxic than inorganic forms, and has a strong tendency to bioaccumulate through the foodchain.

The biogeochemistry of mercury is complex in an aqueous system, but in general, the highest rates of mercury methylation are expected in areas that undergo wet and dry periods, such as tidal wetlands and floodplains. Sufficient organic material and sulfur are required to support mercury methylation. Methylation of mercury also occurs in other permanently inundated areas, but at lower rates.

Conservation Measure CM12, Methylmercury Mitigation, provides strategies to minimize the mobilization of mercury associated with BDCP restoration actions that involve inundation of mercury-containing areas. CM12 includes a comprehensive list of mitigation measures currently being researched or considered to address mercury methylation. These measures will be considered for integration into BDCP restoration planning, design and adaptive management strategies. Through adaptive management, CM12 will integrate study results and new information as new research results become available to inform planning for mercury mitigation in future restoration actions.

The purpose of this memorandum is to present current information on one of the identified mitigation strategies, referred to as Low Intensity Chemical Dosing (LICD). LICD was developed as part of USGS' Subsidence Reversal and Carbon Capture Farming Program (CCFP)

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at a pilot restoration project on Twitchell Island. LICD has potential to provide the following benefits:

- Increased sediment accretion in restored areas to counteract historic land subsidence in the Delta islands, and improve levee stability.
- Sequestration of carbon dioxide in wetland cattails (*Typha* spp) and tules (*Scirpus californicus*)
- Sequestration of dissolved organic carbon in LICD floc
- Sequestration of mercury in LICD floc

The information contained in this memo is primarily based on information provided in the following documents which were supplied by Tim Vendlinski, Senior Policy Advisor, Office of the Director (WTR-1), EPA Pacific Southwest Region.

- Regional Applied Research Effort (RARE) Proposal for "Evaluating a water treatment method to prevent the formation and export of MeHg in restored wetlands and ricelands of the Sacramento-San Joaquin Delta (Delta)" prepared by the USEPA and the USGS
- Regional Applied Research Effort (RARE) and Regional Methods (RM) Proposal for Evaluating a water treatment method to prevent the formation and export of MeHg in restored wetlands and ricelands of the Sacramento-San Joaquin Delta (Delta). Regional Contact: Tim Vendlinski

Approach

The LICD process is based on the tendency of methylmercury to be chemically associated with dissolved organic carbon (DOC). The LICD process involves treating water with the metal based coagulants, such as iron sulfate or polyaluminum chloride, which bind with DOC and associated methylmercury, to form a floc that precipitates out of solution and is deposited as sediment. These coagulants are routinely used to remove DOC from drinking water. The LICD pilot program involves treating drainage waters from subsided peat islands with coagulants, then passing the coagulated water through wetland cells where the floc can settle out prior to export to adjacent Delta channels.

The floc and the natural wetland vegetative matter rapidly accrete to raise the surface of the wetland, which is located in a subsided Delta island, while also sequestering methylmercury and carbon. Laboratory studies indicate that up to 90% of the elemental mercury and 70% of the methylmercury can be removed from the water column using LICD treatment (Henneberry et al. 2011). Preliminary studies indicate that the floc formed by this process is stable under reducing conditions, and may even have capacity to sorb additional mercury in the system (Henneberry et al., in press, unpublished). This initial research suggests that the methylmercury would not be remobilized after treatment.

In deeply subsided areas of the Delta, restoration to a more natural hydrology, and particularly a tidal regime, would require substantially increasing the ground surface elevation. Otherwise, the low-elevation, subsided areas would be subject to deep (up to 20 feet), permanent standing water when flooded. Field studies at Twitchell Island showed that cattails (*Typha* spp) and tules (*Scirpus californicus*) accreted enough vegetative matter to increase land surface elevations by 2 to 4.5 cm/yr, which is approximately 40 times the natural, historic accretion rate (Miller et al. 2011).

Uncertainties

As currently applied in pilot testing, LICD requires a treatment cell for sedimentation and retention of the floc. This design would preclude tidal systems which require the natural ebb and flow of water. However, in the subsided islands of the Delta, a managed wetland with rapidly accreting sediment may be considered as in interim step to increase the elevation to allow a tidal regime. The alternative would be filling the area to the required grade.

Only initial studies are available to inform our current understanding of the potential of the LICD process. Additional field testing to evaluate the full efficacy of implementing the LICD process to address mercury methylation for BDCP restorations areas will be necessary. Of particular interest are the effects of sequestering mercury in an area, how that might impact the ecosystem and food chain within that area, and if the mercury could be remobilized. Because the process takes a load of mercury from an area and deposits it into the smaller area of the treatment cell, there is potential for concentration of high levels of mercury in the sediments. Researchers believe that because the DOC and methylmercury are precipitated together into the floc, the ratio of organic matter to mercury would not be changed, and thus on a per carbon basis the concentration of the methylmercury would not be increased. Further, because of the added deposition of vegetative matter from wetland vegetation, the sediment concentration of methylmercury could actually be decreased (Jacob Fleck, personal communication). Additional studies would be required to evaluate the concentrations of methylmercury in the treatment cell, and if it is permanently sequestered or if it could be remobilized.

References

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